INSTRUCTION MANUAL

FOR THE

[redacted] STAT

(Engineering Prototype)

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PRECAUTIONS

The unit accompanying these instructions is an engineering prototype, not a production prototype, and was wired and assembled by the engineers, who in many instances sacrificed neatness for expediency. It will serve as a demonstrator only if carefully handled. It must be returned in working order, as extensive environmental tests are planned for it. No attempt at disassembly should be made. This phase of evaluation should await the completion of production prototypes.

Do not insert batteries unless the unit is turned OFF.

Do not touch the case of the unit to the case of the transmitter.

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DESCRIPTION

The [ ] is housed in a moderately rugged anodized aluminum case, 1 23/32 X 7 3/4 X 4 1/32. It is supplied with an adapter cord for connection to the particular type of transmitter to be used. 50X1

One face of the unit contains a complete teletype keyboard. The button spacing is reduced, but rows are staggered and arranged so that average typewriter users can touchtype at normal speed with very little practice. Above the top row of buttons are ten tiny holes which are numbered one through nine and zero. These holes glow in turn when a numerically encrypted message, stored in the memory, is being checked for errors. [In the production [ ] these holes also allow the operator to read and copy down messages which have been received off-the-air and stored in the memory.] 50X1 ?

An additional hole, centrally located and labeled READY, tells the operator when the memory is full, and also indicates the condition of the batteries.

On the opposite face of the unit are two disc-like knobs, two buttons, and a pair of folding doors. The latter, when opened, receive the flashlight batteries and act as supports during preparation of a message. A magic zipper strap is fastened over the batteries to hold them in place.

One of the two knobs turns the unit ON and OFF and selects which of the three memory sections (each with a capacity of 238 characters) is in use. The second knob has five positions labeled SEND, RECEIVE, TYPE, BACKSPACE, and READ, all self-explanatory.

The smooth button labeled GO initiates automatic transmission of a stored message when SEND is in use. The same GO button backs through the stored message one space at a time when BACKSPACE is in use. It steps ahead through the stored message one space at a time in READ, causing one of the holes in the keyboard to light for digits in a numerical message.

The rough button, colored red and labeled EMERGENCY ERASE, eradicates all messages stored in the keyer instantly when pressed. (It is not wired up in the demonstrator.)

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A connector is located at one corner of the case. It receives one end of the adapter cord which connects the [redacted] to the transmitter. Various types of adapter cords may be connected here, for plugging into different transmitters and receivers. Only two or three of the twenty contacts in the connector are active in many applications. Some of the contacts provide voltages from the [redacted] batteries for use by a pocket transmitter; or, power from another source may be applied in place of the [redacted] batteries. A wide variety of cords and devices can be made-to-order for operations involving the [redacted] without the need for internal modifications.

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IMPORTANT

1. FSK vs. CW Operation

The keying waveform observed when the CW adapter cord is connected to a 30V or higher DC supply, via a resistive load giving up to 100 ma., is excellent. There is No tail on the turn off slope. However, the voltage observed across the key jack of the RT-6 during keying displays a marked tail after turn off, due to the 0.5 mfd capacitor bypassing the keying point (DC wise). The RF envelope also shows a long tail. With the most active crystals, the tail extends at almost full RF amplitude for almost the full code unit width, greatly shortening the space duration of the teletype character. The 0.5 mfd capacitor and the DC voltage tail seem to be entirely responsible for this problem, with active crystals continuing to oscillate until the cathode voltages rise to proper cutoff. The result is disastrous to speed margins, and the page printer timing adjustment becomes critical. Until a satisfactory disposition can be made, demonstrations using CW should be made only with selected crystals. A scope on the antenna terminals provides rapid checking.

The FSK adapter cord furnished may be used to relieve this problem, although the operating instructions furnished assume CW operation. To use the FSK cord, insert it in the crystal socket with the cord leading across the transmitter body. Insert the crystal in the adapter. Here again the crystal should be selected to give a good shift. Doubling or even tripling of crystals below 4 or 5 MC should be used, so that receiver tuning will not be too critical because of low shift.

A special effort will be devoted to development of keying arrangements which can utilize the clean output of the [redacted] to full advantage. Use of RT-6 high speed modifications may be necessary. It is felt at this time that the present FSK arrangement is too simplified and variable for trustworthy use.

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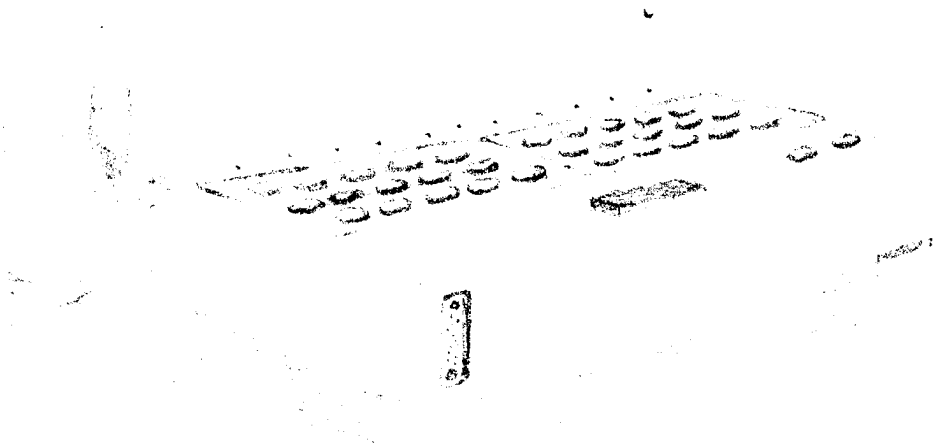
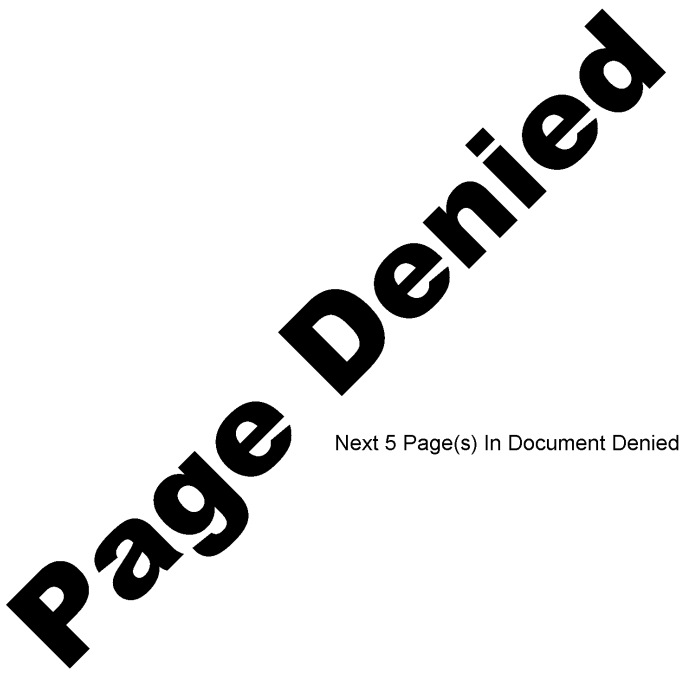
2. Flaws in the Engineering Prototype

Due to solder damage of the aperture plates while affixing leads to the plated winding, this demonstrator will scramble three characters (34, 50, and 81) in "I" and two characters (35 and 36) in "III" (inclusive of opening spaces).

After several days of use, there have been indications that a "butchered" switch section in the "I-II-III-OFF" switch may be going bad. The unit may be observed to malfunction when this switch is moved between II and III. This switch will not be replaced at this time. To restore operation, move to OFF, count ten, and proceed as usual.





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INTRODUCTION

The [ ] is a self-contained, battery operated teletypewriter capable of storing a 714-character message and, in conjunction with an agent transmitter, retransmitting it in less than three minutes, any number of times, after having been carried between sites with power removed. The [ ] makes it possible for [ ] 50X1

As new messages are typed into the computer memory within the [ ] old ones are erased automatically. The memory never wears out, and would retain a given message permanently if kept away from magnets and strong magnetic fields. Immediate correction of typing mistakes is possible while preparing the message, by using a backspace button. All numerical messages may be checked for mistakes after preparation, using a message reading device built-in in the [ ] 50X1

The [ ] uses either two plug-in-rechargeable flashlight batteries or four standard flashlight cells. Battery drain is half that of a flashlight. The connection to the transmitter is simply made in place of the usual telegraph key. Aside from switches and battery holders, there are no moving parts in the [ ] Stock-item solid state devices and magnetic cores are used exclusively in the circuitry. 50X1

The [ ] may be employed effectively after brief written or oral instruction. 50X1

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OPERATING INSTRUCTIONS

NOTE: All functions other than TYPE and SEND are only conveniences and should not be allowed to lead to confusion. The [redacted] is analogous to any typewriter. Doubtful matters can be resolved quickly by experimentation. 50X1

1. Unlatch the doors and insert the batteries, flat end first. Observe symbols engraved under each battery. Smooth the edges of the straps together to hold the batteries. The unit must be TURNED OFF before inserting or removing batteries.

2. Rotate one knob from OFF to "I". Follow the arrow. Rotate the other knob to SEND and press the GO button. The READY light will flash regularly; at length it will shine steadily. (This preliminary is advisable on the demonstrator when leaving the OFF position).

A. Preparing a Message

3. Move to TYPE and to "I". Start with two spaces. When the 241st character is typed the READY lamp will shine steadily, indicating a filled memory section. Move to "II" type two spaces and continue typing. (The 241st character is never stored. On this demonstrator it is good practice to make it a LTRS. Put the desired character first in the next memory section following the initial two spaces. 236 total useful characters including spaces in the message are therefore stored in each section).

4. To correct a mistake, move to BCKSPC. GO becomes a backspace button. Typing the correct character corrects the mistake: backspace itself does not erase anything. READY should be ignored.

5. When a numerical message has been stored it may be checked in entirety. Move to READ. The GO button is used to step forward through the stored message one character at a time. Each stored number lights a corresponding lamp in the keyboard. Stored spaces do not light a lamp. Each mistake discovered in this way may be corrected with BCKSPC.

B. Transmitting the Message

6. Connect the adapter cord to one corner of the unit and into the external key jack of the transmitter, after completing the normal transmitter tuning operations. The built-in key of the RT-6 must be in the extended position. Move to SEND and to "I". Push GO. When READY stops flashing and glows steadily, move to "II" and push GO. Finally, "III".

7. Retransmit any number of times, in any desired order of memory sections "I", "II" or "III". Once the knob has been rotated correctly from the OFF position it may be rotated in either direction, unless moved near OFF. Always rotate with deliberation, never spinning rapidly, to avoid erasing the message.

C. Emergency Erase

8. Press briefly at any time. Avoid habitual use. This button is rough, while GO is smooth, for tactile identification.

BATTERIES

The READY light may be used as an indication of weak batteries. When it cannot be seen flashing during SEND after GO is pressed, the operator should take action to renew the batteries. However, as long as READY may be seen indoors while glowing steadily, the battery condition is sufficient for operation. Plug-in-recharge batteries and other nickel-cadmium cells will be unuseable and must be recharged minutes after READY cannot be seen when flashing, whereas ordinary flashlight cells continue to drop in voltage at a fairly steady rate after this point is reached.

The plug-in-recharge batteries and other nickel-cadmium cells normally light READY to a yellow color even when fully charged. Fresh standard flashlight cells light READY to bright white. This is due to a difference in cell characteristics; actually, the latter are inferior to the former in difficult environments, have short storage life, and are frequently of poor quality when obtained in many areas.

The room-temperature battery drain of the [redacted] is approximately 150 ma. Five or more continuous hours of service are obtainable from fresh standard flashlight cells made in the U. S. A. Life of the cells is greatly increased by occasional or intermittent use, rather than continuous use.

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OTHER DETAILS

If the [redacted] is connected to the transmitter while in TYPE, the message will go out as typed, as well as being stored. (Termed "on-line operation"). This also applies to READ. 50X1

During preparation of a message the operator may type one extra character accidentally after the READY light has come on. As a safety feature, this will not alter the message and the character will not be stored, but the READY light will go out. If this happens, move to SEND, press GO, and wait for the READY lamp to remain on before continuing. For familiarization, continue typing into a memory section after the READY light has come on. The first portion of the stored information will be replaced by what follows the READY light, as would be expected.

Moving the "I-II-III-OFF" knob when the READY light isn't glowing steadily may confuse both the circuitry and the operator. This may be tried out of curiosity if desired. Moving the other knob while READY is flashing may have similar results. If the unit should cease to operate due to knobs being rotated in this manner or due to presence of a powerful magnetic field, rotate to OFF, count ten, and proceed as usual. Repeat this if necessary. This restores all circuits to functioning, but the stored message should be checked for errors afterward.

The buttons labeled LET. and FIG. may be ignored by persons sending numerical messages only.

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BASE STATION PROCEDURE

The receiver and teletypewriter and accessories are set up for either CW or FSK, depending on the type of adapter cord issued with the [redacted] to be received. The message should be put on tape as received. The message begins with a continuous MARK, which proceeds from the point where the [redacted] is turned on. Tuning adjustments must be made before the operator pushes the GO button. Each section ends with a continuous space, during which the receiving machine "runs open". As the operator moves the [redacted] switch from "I" to "II" or from "II" to "III", the carrier returns to continuous mark. A spurious character may be printed at this time.

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PRINCIPLE OF OPERATION

The [redacted] has a non-destructive, character-organized, coincident-current ferrite aperture plate memory. Memory drive currents are obtained from two scanning registers or sequential pulsers of 15 and 16 stages, which drive any of the three subdivisions or bays of the memory via square-loop cores and swamping resistors. The cores also perform the gating function in driving only the selected bay. Swamping resistors are returned to two floating buses, so that drive currents for the addressed row and column are divided equally and returned in reverse direction through all unaddressed rows and columns; in this way, noise due to reversible disturbances is cancelled almost perfectly in the sense wires. The memory bays are character-organized by being composed of five aperture plates sandwiched together and threaded in one operation by the row and column drive wires. Each plate handles one code unit, or baud, of the teletype characters. The plated sense wires connect to five sense amplifiers which also act as buffer stores for conversion from parallel to serial information. Five rewrite drivers also receive the stored information in parallel form from the sense amplifiers and accordingly inhibit the sense wires as write drive currents are applied to the memory, so that the same information which appears on the sense wires from each address in the memory is restored in the same address. To insert new messages, the sense amplifiers are made insensitive to sense wire pulses, and respond only to larger pulses obtained from five square-loop cores of a wired-logic character generation matrix in the typewriter keyboard. This information, rather than the old, is then inserted in the memory by the rewrite drivers.

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A unijunction relaxation oscillator serves as a clock, and is keyed into operation by a control flip-flop. The clock produces eight pulses at 22 Msec/intervals for each teletype character. An eight stage ring counter driven indirectly by the clock performs the parallel-to-serial conversion at the sense amplifiers. The control flip-flop is reset at the end of one bay scan by a pulse derived from simultaneous firing of the 15th and 16th stages of the scanning registers. If a new message is typed, the ring counter's eighth stage is bypassed, and it makes only one cycle when a key closes, stopping the clock after seven

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pulses by resetting the control flip-flop. The message is thus stored at the operator's own rate, but almost all circuitry operates in its normal manner, and the teletype characters appear as typed at the serial output. The memory stores only the five information bauds of each teletype character. The start and stop pulses are derived from the ring counter outputs.

Formation of a clean teletype character is done by the output flip-flop, which provides normal and inverted outputs, decoupled from the rest of the circuit, in the form of two transistor switches which may be utilized in many different ways by the various adapter cords. The stop pulse has a 44 Msec. duration, resulting in 56.8 wpm equivalent transmission rate. This feature is entirely compatible with standard teletype nets, and results in no reduction of speed margin.

The read/write cycle of the memory and its drive circuits takes place in a 30 microsecond interval as the leading edge of the start pulse of the teletype character is being formed. These circuits are all dormant during the 0.176 second interval between characters, and, being off-biased, draw only small leakage current. The sense amplifiers each have a single transistor, drawing 0.5 ma. The only two flip-flops draw 1 ma. apiece. These factors contribute to the low power drain of the CK-14.

The high degree of circuit simplicity has made possible use of shelf-item components and straightforward printed-circuit construction in the small volume of the [redacted] (Although the construction which grew with the engineering prototype is not entirely satisfactory.) This simplicity comes about through use of solid state/square-loop core circuits which are finding their way into industry and are known by various trade names such as "Bimag". These circuits supply pulses of several hundred milliamperes and many volts closely regulated in amplitude, duration, and shape, and having current-or-voltage-source characteristics as desired. These circuits are mutually independent, are capable of being triggered and triggering other circuits in turn, and are inherently capable of wired-logic operations. 50X1

Regulation of the various pulse amplitudes is accomplished centrally, rather than in each driver, by regulation of the supply voltages. A duty-cycle-regulated DC-DC converter with unijunction/zener voltage sensing provides almost perfect short-term regulation with load and with battery voltage variations of 3:2. Long-term regulation with both age and temperature is of the order of only a few percent and is well within requirements of the CK-14 circuitry. An additional unijunction thermal regulator matches drive current amplitudes to the ferrite aperture plates' temperature characteristics. (The actual prototype model, with unselected components, tolerates errors in drive current amplitude of ±7% about the correct value; probable variations due to tolerance build-up, temperature, and other factors do not exceed this value.)

The built-in readout device consists of ten silicon controlled switches (TRIGGERED) via ten transistor buffers by a wired-core matrix. The five cores of this matrix are driven by collector currents of the rewrite drivers, thus receiving information which is already in parallel form. In the READ function, the [redacted] operates as in TYPE except that the sense amplifiers are not made insensitive to information on the sense wires. The readout device assembly may be connected to or disconnected from the main circuit without affecting it. Certain portions of the main circuit are almost this independent. This makes troubleshooting of the keyer during assembly surprisingly easy in spite of its diagrammatic complication.

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APPENDIX

DISCUSSION

The memory is divided into the three sections "I", "II" and "III" partly for convenience to the operator, who by use of the various operating features can find his place very rapidly if he should lose it while preparing the message. Also, three brief messages could be prepared in advance for various contingencies. This division can be eliminated if desired, prior to production prototype construction.

The full teletype keyboard entails no additional electronic components beyond those which would be required for a ten-number abbreviated keyboard transmitting only the teletype numerals. The full keyboard does require $100 in electronic components over the rudimentary system which substitutes teletype letters for numerals, and which requires additional procedures at the base station. No significant increase in case size results from use in the [redacted] of the full teletype keyboard, due to the thinness of the keyboard assembly and the fact that sufficient area is already available, and the components mentioned amount to three tiny ferrite plates, two transistors, and several small parts. 50X1

Since the [redacted] inherently performs all the functions of a teletypewriter, the buttons contain many rarely used upper-case characters such as exclamation points and dollar signs. It is feasible to alter the inscriptions on the buttons to characters of alphabets which contain up to 51 letters, and to install corresponding type face in the receiving page printer at the base station. No internal modification of the [redacted] is involved. In a similar manner, it is feasible to transmit two-digit numbers such as 11, 12, 24, etc. as a single character, and to print these two-digit numbers in reduced size with a single stroke at the page printer. The full 120-group capacity of the [redacted] memory may thus be realized in the case of numerical messages. 50X1 50X1 50X1

UNDER DEVELOPMENT

The engineering prototype has been made available for demonstration in advance of the incorporation within its housing of several additional features, which require testing and development. Most of the anticipated wiring for these features has already been installed, and they can be added or removed without affecting what has already been done, due to the versatility of the main circuitry. They will be described briefly.

A switch will be installed which will select either 60 wpm or 1600 wpm operation. At the latter speed the three parts of the message can be sent in only 1 1/2 seconds each, with complete message taking perhaps ten seconds due to delays in moving the switch. (1600 wpm operation is practical only over relatively short transmission paths, due to multipath, unless the type of output from the CK-14 is substantially altered. The required type of output exists within the keyer and can be provided in special models. A frequency standard accessory governing code unit width will also be provided. These special models will require a QFM transmitter similar to the RS-16.)

A Y-shaped connector cord will be provided for connecting the [redacted] as well as a transmitter. In the RECEIVE position of the selector switch messages transmitted from the base station teletypewriter will be stored in the [redacted] at a 60 wpm rate. The READ position can then be used to copy numerical messages onto paper at the operator's leisure. Messages will be transmitted from [redacted] in three parts, with brief intervals for the operator to switch between memory sections. With consideration of multipath, 1600 wpm messages can also be received. 50X1 50X1 50X1

Note that these features permit one [redacted] to transmit to another [redacted] 50X1 50X1

Use of th[redacted] for transmission and reception of teletype messages will be feasible, since with the proper adapter cord the [redacted] is capable of keying the most powerful of transmitters. 50X1 50X1

Tiny batteries are used in the [redacted] for emergency erase. 50X1
They are trickle-charged whenever the regular batteries are in use. A modification of the circuit is planned which will permit use of these batteries for transmission of a single message from body concealment, without the bulky flashlight cells. This development may not be given priority unless a real need exists.

A pocket transmitter is being designed under a separate project for use with the [redacted] This transmitter will employ dual-oscillator frequency-shift keying and will be capable of 1600 wpm 50X1
or 60 wpm operation. It may use the same batteries as the [redacted] 50X1
and to this end battery voltage outputs have already been provided
in the [redacted] connector. 50X1

Eventual development of a complete [redacted] including 50X1
receiver, transmitter, and [redacted] with extremely simple assembly 50X1
and operating procedure, has been proposed.

PRODUCTION

The planning and construction of the production prototype will proceed simultaneously with a production and test plan. Many construction simplifications not foreseen in development of the engineering prototype have already appeared. Reliability will be the primary concern; elimination of unnecessary labor and difficult steps will be next. Space saved through hindsight of the engineering prototype will be devoted to uncrowding the modules and components, but some size reduction may be realized. Actual work on the production prototype will await final environmental tests of the engineering prototype. Some final circuit development is planned, and a re-examination of all circuit margins may lead to other minor changes in the interior.